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**JA6.1 Fault Indicator Display (FID)****JA6.1.1 Purpose and Scope**

Joint Appendix JA6.1 defines required elements for fault indicator display technologies that utilize instrumentation and computer software functionality to monitor and determine the operating performance of vapor compression air conditioning and heat pump systems, to provide visual indication to the system owner/operator if the system's refrigerant charge or metering device performance does not conform to approved target parameters for minimally efficient operation.

JA6.1.6 specifies the required instrumentation, instrumentation accuracy, parameters measured, required calculations, allowable deviations from target values for system operating parameters, and the requirements for system fault indication for a fault indicator display technology that conforms to the methods for verifying refrigerant charge and metering device performance described in Reference Residential Appendix RA3.2.2.

Fault indicator display technologies other than what is described in Section JA6.1 are possible, and when vapor compression air conditioner and heat pump system refrigerant charge, metering device and airflow operating performance can be reliably determined by methods and instrumentation other than those specifically defined in section JA6.1 such alternative fault indicator display technologies may be allowed for Fault Indicator Display compliance credit if the manufacturer of the product requests approval from the Energy Commission. The Commission may grant such approval after reviewing submittals from the applicant. Fault indicator display technologies that are approved by the Commission shall be specified in documentation that will be published as an addendum to this appendix.

The applicant shall provide information that specifies the required instrumentation, the instrumentation accuracy, the parameters measured, the required calculations, the allowable deviations from target values for system operating parameters, and the requirements for system fault indication.

**JA6.1.2 FID Product Approval**

Fault indicator display technology manufacturers shall certify to the Energy Commission that the fault indicator display technology meets the requirements of Reference Joint Appendix JA6.1.

**JA6.1.3 FID Installation**

Fault indicator display devices shall be factory installed by the space-conditioning system manufacturer, or field installed according to the space-conditioning system manufacturer's requirements and the FID manufacturer's specifications.

**JA6.1.4 FID Product Documentation**

Manufacturers of FID technologies shall, upon request, provide comprehensive engineering specification documentation, installation and technical field service documentation, and homeowner user instructions documentation to designers, installers, service personnel and homeowners who utilize the technology.

**JA6.1.5 Optional Fault Detection Capabilities**

The FID may also be used to signal other system operation faults as long as these additional functions do not detract from the proper function of the refrigerant charge, metering device, or airflow operation indications.

**JA6.1.6 Requirements for a Fault Indicator Display**

This section specifies the required instrumentation, the instrumentation accuracy, the parameters measured, the required calculations, the allowable deviations from target values for system operating parameters, and the requirements for system fault indication for a fault indicator display technology.

**JA6.1.6.1 Instrumentation Specifications**

Instrumentation for the procedures described in JA6.1.6 shall conform to the following specifications:

**JA6.1.6.1.1 Temperature Sensors**

The temperature sensors shall have an accuracy of plus or minus 1.8°F.

**JA6.1.6.1.2 Refrigerant Pressure Sensors**

Refrigerant pressure sensors shall have an accuracy of plus or minus 3 percent of full scale.

**JA6.1.6.1.3 Parameters Measured**

The following parameters shall be measured:

- (a) Suction line temperature ( $T_{\text{suction, l}}$ ).
- (b) Liquid line temperature ( $T_{\text{liquid}}$ ).
- (c) Evaporator saturation temperature or low side refrigerant pressure ( $T_{\text{evaporator, sat}}$ ).
- (d) Condenser saturation temperature or high side refrigerant pressure ( $T_{\text{condensor, sat}}$ ).
- (e) Return air wet bulb temperature or humidity ( $T_{\text{return, wb}}$ ).
- (f) Return air dry bulb temperature ( $T_{\text{return, db}}$ ).
- (g) Condenser air entering dry bulb temperature ( $T_{\text{condenser, db}}$ ).
- (h) Supply air dry bulb temperature ( $T_{\text{supply, db}}$ ).

**JA6.1.6.2 Refrigerant Charge, Metering Device, and Airflow Calculations**

Refrigerant charge, metering device and airflow calculations for determining superheat, subcooling, and temperature split values shall conform to the specifications of this section utilizing the measured parameters data from instrumentation as specified in Section JA6.1.6.1.

**JA6.1.6.2.1 Fixed Metering Device Calculations**

The fixed metering device calculations are used only for systems equipped with fixed metering devices. These include capillary tubes and piston-type metering devices.

- (a) Calculate Actual Superheat as the suction line temperature minus the evaporator saturation temperature.  $\text{Actual Superheat} = T_{\text{suction, l}} - T_{\text{evaporator, sat}}$ .
- (b) Determine the Target Superheat using Reference Residential Appendix RA3 Table RA3.2-2, the return air wet-bulb temperature ( $T_{\text{return, wb}}$ ) and the condenser air entering dry-bulb temperature ( $T_{\text{condenser, db}}$ ). If a dash mark is read from Reference Residential Appendix RA3 Table RA3.2-2, the target superheat is less than 5°F.
- (c) Calculate the difference between Actual Superheat and Target Superheat (Actual Superheat - Target Superheat)

**JA6.1.6.2.2 Variable Metering Device Calculations**

The variable metering device calculations are used only for systems equipped with variable metering devices. These include Thermostatic Expansion Valves (TXV) and Electronic Expansion Valves (EXV).

- (a) Calculate Actual Subcooling as the condenser saturation temperature minus the liquid line temperature.  $\text{Actual Subcooling} = T_{\text{condenser, sat}} - T_{\text{liquid}}$ .
- (b) Determine the Target Subcooling specified by the manufacturer.
- (c) Calculate the difference between actual subcooling and target subcooling (Actual Subcooling - Target Subcooling).

- (d) Calculate Actual Superheat as the suction line temperature minus the evaporator saturation temperature.  $\text{Actual Superheat} = T_{\text{suction}} - T_{\text{evaporator, sat}}$ .
- (e) If possible, determine the Superheat Range specified by the manufacturer.

#### JA6.1.6.2.3 Minimum Airflow Calculations

The minimum airflow calculations are designed to determine whether the rate of airflow across the evaporator coil is above the minimum airflow rate requirement for a valid refrigerant charge test result.

- (a) Calculate the Actual Temperature Split as the return air dry-bulb temperature minus the supply air dry-bulb temperature.  $\text{Actual Temperature Split} = T_{\text{return, db}} - T_{\text{supply, db}}$
- (b) Determine the Target Temperature Split from Table JA6.1-1 using the return air wet-bulb temperature ( $T_{\text{return, wb}}$ ) and return air dry-bulb temperature ( $T_{\text{return, db}}$ ).
- (c) Calculate the difference between target and actual temperature split (Actual Temperature Split - Target Temperature Split).

#### JA6.1.6.3 System Fault Indication

Data from instrumentation specified in Section JA6.1.6.1 and calculations specified in Section JA6.1.6.2 shall be processed and interpreted continuously or at sufficiently frequent time step intervals, during normal system operation, to insure that system operating conditions that meet the system fault criteria of this section will be detected, and indicated by the fault indicator display. Data from instrumentation specified in Section JA6.1.6.1 and calculations specified in Section JA6.1.6.2 shall be processed and interpreted in a manner that prevents indication of system faults when system fault criteria are triggered by temporary or transitory operating conditions that are not true indicators of problems with refrigerant charge, metering device, or airflow performance.

The fault indicator display shall:

- (a) be clearly visible to occupants of the home during normal operation.
- (b) be located on or within one foot of (one of) the thermostat(s) controlling the air conditioner.
- (c) display an indication of a system fault requiring service or repair when system normal operation fails to meet the required operating performance criteria specified in this section. These system fault indications shall be displayed for a period of at least 7 days after a system fault is detected unless the fault indicator display is reset by the installing or servicing technician.

##### 1. Refrigerant charge verification criterion for fixed metering device systems.

If the air conditioner has a fixed metering device, runs for 15 minutes, has a Target Superheat value determined by Reference Residential Appendix RA3 Table RA3.2-2 that is greater than or equal to 5°F, the condenser air entering temperature is greater than or equal to 65°F, and the minimum airflow requirement from item d below is satisfied, then the conditions for a valid refrigerant charge test are satisfied.

If the conditions for a valid refrigerant charge test are satisfied, and the air conditioner has an Actual Superheat value that deviates more than plus or minus 10°F from the Target Superheat value determined by Reference Residential Appendix RA3 Table RA3.2-2, then the system fails the refrigerant charge test, and a system fault shall be reported.

##### 2. Refrigerant charge verification criterion for variable metering device systems.

If the air conditioner has a TXV or EXV, runs for 15 minutes, the condenser air entering temperature is greater than or equal to 65°F, and the minimum airflow requirement from item d below is satisfied, then the conditions for a valid refrigerant charge test are satisfied.

If the conditions for a valid refrigerant charge test are satisfied, and the air conditioner has an Actual Subcooling value that deviates more than plus or minus 6°F from the Target Subcooling value listed by the manufacturer, then the system fails the refrigerant charge test, and a system fault shall be reported.

##### 3. Variable metering device function verification criterion.

If the air conditioner has a TXV or EXV, runs for 15 minutes, the condenser air entering temperature is greater than or equal to 65°F, and the minimum airflow requirement from item d below is satisfied, then the conditions for a valid metering device test are satisfied.

If the conditions for a valid metering device test are satisfied, and the air conditioner has an Actual Superheat value outside the range specified by the manufacturer (or outside the range 2°F to 28°F if there is no manufacturer's specification), then the system fails the metering device test, and a system fault shall be reported.

4. Minimum airflow verification criterion.

If the air conditioner runs for 15 minutes, and the condenser air entering temperature is greater than or equal to 65°F, then the conditions for a valid minimum airflow test are satisfied.

If the conditions for a valid minimum airflow test are satisfied, and the air conditioner has an Actual Temperature Split value that deviates more than plus 5°F from the Target Temperature Split value determined by Table JA6.1-1, then the system fails the minimum airflow test, and a system fault shall be reported.

#### **JA6.1.6.4    Optional Functionality**

The fault indicator display devices may be set to tighter specifications than those specified in Section JA6.1.6.3. The fault indicator display may also be used to signal other system faults as long as these additional diagnostic functions do not detract from the accuracy of the measurement and reporting of system faults as specified in Section JA6.1.6.3.

##### **JA6.1.6.4.1    Self Diagnostic Reporting**

When equipped with self diagnostic reporting functionality, the FID shall check for communication with every sensor and provide an indication when there are any sensor failures.

##### **JA6.1.6.4.2    Data Access**

In order to provide for verification of sensor data and FID system functionality, data access shall be provided. The FID manufacturer shall specify the data access method(s), and the minimum data reporting capability including requirements for any data history reporting.

Table JA6.1-1 Target Temperature Split (Return Dry-Bulb – Supply Dry-Bulb)

Return Air Dry-Bulb (°F) (T return, db)	Return Air Wet-Bulb (°F) (T return, wb)																											
		50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
	70	20.9	20.7	20.6	20.4	20.1	19.9	19.5	19.1	18.7	18.2	17.7	17.2	16.5	15.9	15.2	14.4	13.7	12.8									
	71	21.4	21.3	21.1	20.9	20.7	20.4	20.1	19.7	19.3	18.8	18.3	17.7	17.1	16.4	15.7	15.0	14.2	13.4	12.5								
	72	21.9	21.8	21.7	21.5	21.2	20.9	20.6	20.2	19.8	19.3	18.8	18.2	17.6	17.0	16.3	15.5	14.7	13.9	13.0	12.1							
	73	22.5	22.4	22.2	22.0	21.8	21.5	21.2	20.8	20.3	19.9	19.4	18.8	18.2	17.5	16.8	16.1	15.3	14.4	13.6	12.6	11.7						
	74	23.0	22.9	22.8	22.6	22.3	22.0	21.7	21.3	20.9	20.4	19.9	19.3	18.7	18.1	17.4	16.6	15.8	15.0	14.1	13.2	12.2	11.2					
	75	23.6	23.5	23.3	23.1	22.9	22.6	22.2	21.9	21.4	21.0	20.4	19.9	19.3	18.6	17.9	17.2	16.4	15.5	14.7	13.7	12.7	11.7	10.7				
	76	24.1	24.0	23.9	23.7	23.4	23.1	22.8	22.4	22.0	21.5	21.0	20.4	19.8	19.2	18.5	17.7	16.9	16.1	15.2	14.3	13.3	12.3	11.2	10.1			
	77	-	24.6	24.4	24.2	24.0	23.7	23.3	22.9	22.5	22.0	21.5	21.0	20.4	19.7	19.0	18.3	17.5	16.6	15.7	14.8	13.8	12.8	11.7	10.6	9.5		
	78	-	-	-	24.7	24.5	24.2	23.9	23.5	23.1	22.6	22.1	21.5	20.9	20.2	19.5	18.8	18.0	17.2	16.3	15.4	14.4	13.4	12.3	11.2	10.0	8.8	
	79	-	-	-	-	-	24.8	24.4	24.0	23.6	23.1	22.6	22.1	21.4	20.8	20.1	19.3	18.5	17.7	16.8	15.9	14.9	13.9	12.8	11.7	10.6	9.4	8.1
	80	-	-	-	-	-	-	25.0	24.6	24.2	23.7	23.2	22.6	22.0	21.3	20.6	19.9	19.1	18.3	17.4	16.4	15.5	14.4	13.4	12.3	11.1	9.9	8.7
	81	-	-	-	-	-	-	-	25.1	24.7	24.2	23.7	23.1	22.5	21.9	21.2	20.4	19.6	18.8	17.9	17.0	16.0	15.0	13.9	12.8	11.7	10.4	9.2
	82	-	-	-	-	-	-	-	-	25.2	24.8	24.2	23.7	23.1	22.4	21.7	21.0	20.2	19.3	18.5	17.5	16.6	15.5	14.5	13.4	12.2	11.0	9.7
83	-	-	-	-	-	-	-	-	-	25.3	24.8	24.2	23.6	23.0	22.3	21.5	20.7	19.9	19.0	18.1	17.1	16.1	15.0	13.9	12.7	11.5	10.3	
84	-	-	-	-	-	-	-	-	-	25.9	25.3	24.8	24.2	23.5	22.8	22.1	21.3	20.4	19.5	18.6	17.6	16.6	15.6	14.4	13.3	12.1	10.8	